Practitioner's Docket No. AP9671

CHAPTER II

TRANSMITTAL LETTER TO THE UNITED STATES ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/EP00/06955	20/July/2000	21/July/1999
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED

Method and Circuit Arrangement for Controlling a Vehicle
TITLE OF INVENTION

Norbert Ehmer; Rainer Klusemann; Lothar Kienle; Bernd-Uwe Hartmann; Ulrich Stockmann;
APPLICANT(S)

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

NOTE: To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

WARNING: *Where the items are those which can be submitted to complete the entry of the international application into the*

CERTIFICATION UNDER 37 C.F.R. 1.10*
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I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on this date 1/22/02 in an envelope as "Express Mail Post Office to Addressee," Mailing Label Number EV051018972US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Joyce Krumpe
(type or print name of person mailing paper)

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Signature of person mailing paper

WARNING: *Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.*

****WARNING:*** *Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).*
*"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. §1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - See 37 C.F.R. §1.8.

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111. 37 C.F.R. § 1.494(f).

1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

   a. [X] This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).

   b. [X] The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2.Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
[ ]*	TOTAL CLAIMS	15 - 20 =		x $ 18.00 =	$
	INDEPENDENT CLAIMS	3 - 3 =		x $ 84.00 =	
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + $280.00				
BASIC FEE**	[ ] U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: [ ] and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(2) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) ..... $100.00 [ ] and the above requirements are not met (37 CFR 1.492(a)(1)) ..... $710.00 [X] U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: [ ] has been paid (37 CFR 1.492(a)(2)) ..... $740.00 [ ] has not been paid (37 CFR 1.492(a)(3)) ..... $1040.00 [X] where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) $890.00				
	Total of above Calculations				= 890.00
SMALL ENTITY	Reduction by ½ for filing by small entity, if applicable. Affidavit must be filed. (note 37 CFR 1.9, 1.27, 1.28)				-
	Subtotal				890.00
	Total National Fee				$ 890.00
	Fee for recording the enclosed assignment document $40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				
TOTAL	Total Fees enclosed				$ 890.00

*See attached Preliminary Amendment Reducing the Number of Claims.

i. [ ] A check in the amount of _____ to cover the above fees is enclosed.

ii. [X] Please charge Account No. 18-0013 in the amount of $ 890.00.

A duplicate copy of this sheet is enclosed.

**WARNING. *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.*

3. [X] A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE: *Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47 1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.*

a. [X] is transmitted herewith.

b. [ ] is not required, as the application was filed with the United States Receiving Office.

c. [ ] has been transmitted

i. [ ] by the International Bureau.
Date of mailing of the application (from form PCT/IB/308): _____.

ii. [ ] by applicant on _____.
Date

4. [X] A translation of the International application into the English language (35 U.S.C. 371(c)(2)):

a. [X] is transmitted herewith.

b. [ ] is not required as the application was filed in English.

c. [ ] was previously transmitted by applicant on _____.
Date

d. [ ] will follow.

5. [ ] Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: *The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.*

a. [ ] are transmitted herewith.
b. [ ] have been transmitted
  i. [ ] by the International Bureau.
  Date of mailing of the amendment (from form PCT/IB/308): ________.
  ii. [ ] by applicant on ______. (Date)
c. [ ] have not been transmitted as
  i. [ ] applicant chose not to make amendments under PCT Article 19.
  Date of mailing of Search Report (from form PCT/ISA/210): ________.
  ii. [ ] the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. [ ] A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):
a. [ ] is transmitted herewith.
b. [ ] is not required as the amendments were made in the English language.
c. [ ] has not been transmitted for reasons indicated at point 5(c) above.

7. [x] A copy of the international examination report (PCT/IPEA/409)
  [x] is transmitted herewith.
  [ ] is not required as the application was filed with the United States Receiving Office.

8. [ ] Annex(es) to the international preliminary examination report
a. [ ] is/are transmitted herewith.
b. [ ] is/are not required as the application was filed with the United States Receiving Office.

9. [ ] A translation of the annexes to the international preliminary examination report
a. [ ] is transmitted herewith.
b. [ ] is not required as the annexes are in the English language.

10. [X] An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115
a. [ ] was previously submitted by applicant on __________. (Date)
b. [X] is submitted herewith, and such oath or declaration
  i. [X] is attached to the application.
  ii. [ ] identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. 1.70.

iii. [ ] will follow.

Other document(s) or information included:

11. [x] An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):
    a. [x] is transmitted herewith.
    b. [ ] has been transmitted by the International Bureau.
       Date of mailing (from form PCT/IB/308): _____.
    c. [ ] is not required, as the application was searched by the United States International Searching Authority.
    d. [ ] will be transmitted promptly upon request.
    e. [ ] has been submitted by applicant on _____.
       Date

12. [X] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98:
    a. [X] is transmitted herewith.
       Also transmitted herewith is/are:
       [X] Form PTO-1449 (PTO/SB/08A and 08B).
       [X] Copies of citations listed.
    b. [ ] will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).
    c. [ ] was previously submitted by applicant on _____.
       Date

13. [X] An assignment document is transmitted herewith for recording.

    A separate [X] "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or[ ] FORM PTO 1595 is also attached.

    _____
    _____
    _____

14. [X] Additional documents:
    a. [ ] Copy of request (PCT/RO/101)
    b. [x] International Publication No. WO01/07306
       i. [ ] Specification, claims and drawing
       ii. [x] Front page only
    c. [X] Preliminary amendment (37 C.F.R. § 1.121)
    d. [ ] Other

    _____
    _____
    _____

15. [X] The above checked items are being transmitted

a. [X] before 30 months from any claimed priority date.
b. [ ] after 30 months.

16. [ ] Certain requirements under 35 U.S.C. 371 were previously submitted by the applicant on _____, namely:

_____
_____
_____

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.*

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

[X] The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. 18-0013.

[X] 37 C.F.R. 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

[X] 37 C.F.R. 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.

[X] 37 C.F.R. 1.17 (application processing fees)
[X] 37 C.F.R. 1.17(a)(1)-(5)(extension fees pursuant to § 1.136(a).
[ ] 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of

allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

[X] 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

Reg. No.: 33,373

Joseph V. Coppola, Sr.
(type or print name of practitioner)

Tel. No.: (248) 594-0650

RADER, FISHMAN & GRAUER PLLC
P.O. Address
39533 Woodward Ave., Suite 140
Bloomfield Hills, MI 48304

CUSTOMER NO.: 010291

AP9671

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Ehmer et al

Int'l Application No.: PCT/EP00/06955

Int'l Filing Date: 20/July/2000

Serial No.: Group Art Unit:

Filed: Herewith Examiner:

For: Method & Circuit Arrangement for Controlling a Vehicle

Attorney Docket No.: AP9671 Paper No.

Box PCT
Assistant Commissioner of Patents
Washington, D.C. 20231
Attn: EO/US

CERTIFICATE OF MAILING/TRANSMISSION (37 CFR 1.8(a))

I hereby certify that this correspondence is, on the date shown below, being:

☑ deposited with the United States Postal Service with sufficient postage as Express Mail, Post Office to Addressee, Mailing Label No.: EV051018972US, addressed to Box PCT, Commissioner of Patents, Washington, DC 20231

☐ transmitted by facsimile to the Patent and Trademark Office. to Examiner _____ at _____

Signature Joyce Krumpe

Date: 1/22/02

Joyce Krumpe

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the application as follows prior to examination on the merits.

IN THE DRAWINGS

Enclosed herewith are three sheets of drawings (Figures 1-3) containing English translation of the German text that appears on the originally filed drawings.

IN THE CLAIMS

Please cancel claims 1-15 and add the following new claims.

16. (New) A method for controlling a vehicle, wherein the rotation behavior of the individual wheels is measured and evaluated in order to determine the vehicle reference speed, wheel slip, wheel acceleration and other control values used for proportioning or modulating the brake pressure in the wheel brakes of the wheels being controlled or for an intervention in the engine management, comprising the steps of:

A) detecting and evaluating the vibration behavior of the individual wheels on the driven axle,

B) detecting and evaluating the wheel acceleration on at least two wheels,

C) activating a control function when said vibration behavior of step A) and said wheel acceleration of step B) both exceed respectively associated threshold value.

17. (New) Method as claimed in claim 16, wherein a gravel road is considered to have been identified or a corresponding control function of the vehicle control system is only activated when the period of a vibration on at least two driven wheels lies within a specified range (T_1, T_2) or when the period of a vibration on at least two driven wheels reaches a specified limit value.

18. (New) Method as claimed in claim 16, wherein the associated threshold value in step B) is specified within a range of 1g to 2g.

19. (New) Method as claimed in claim 16, the method further comprising a gravel road is considered to have been identified or a corresponding control function of the vehicle control system is only activated when the period of a vibration on at least two driven wheels lies within a specified range (T_1, T_2) or when the period of a vibration on at least two driven wheels reaches a specified limit value, wherein a period range (T_1, T_2)

of 30 msec. (T_2) to 150 msec. (T_1) or a limit value for the period of about 50 msec. is specified.

20. (New) Method as claimed in claim 16, wherein a gravel road is then considered to have been identified or a corresponding control function of the vehicle control system is only activated when the driven wheels exhibit a specified traction slip.

21. (New) Method as claimed in claim 16, the method further comprising a gravel road is then considered to have been identified or a corresponding control function of the vehicle control system is only activated when the driven wheels exhibit a specified traction slip, wherein a traction slip is specified within a range of 0 km/h (S_2) to 50 km/h (S_1).

22. (New) Method as claimed in claim 16, wherein a gravel road is then considered to have been identified or a corresponding control function of the vehicle control system is only activated when the calculated or estimated vehicle reference speed (V_{ref}) falls below a specified vehicle speed limit value (V_{lim}).

23. (New) Method as claimed in claim 16, the method further comprising a gravel road is then considered to have been identified or a corresponding control function of the vehicle control system is only activated when the calculated or estimated vehicle reference speed (V_{ref}) falls below a specified vehicle speed limit value (V_{lim}), wherein a vehicle speed limit value (V_{lim}) is specified within a range of 60 km/h to 100 km/h.

24. (New) Method as claimed in claim 16, wherein a gravel road is then considered to have been identified or a corresponding control function of the vehicle control system is only activated when the conditions for a gravel road were identified in a vehicle with all-wheel drive on both wheels of one side of the vehicle and/or a vehicle axle.

25. (New) Method as claimed in claim 16, wherein a gravel road is then considered to have been identified or a corresponding control function of the vehicle control system is only activated when the conditions for a gravel road were identified in a vehicle with one driven axle on both wheels on the driven axle.

26. (New) Method as claimed in claim 16, wherein said control function includes at least one of an anti-lock system (ABS), traction slip control (TCS) or driving-dynamics control system (EDS).

27. (New) Method as claimed in claim 16, wherein an engine control threshold is predefined in a range of 2 km/h to 10 km/h, or a brake control threshold is predefined in a range of 0 km/h to 10 km/h.

28. (New) Method for controlling a vehicle, using an anti-lock system (ABS), traction slip control (TCS) or driving-dynamics control system (EDS), in which the rotation behavior of the individual wheels is measured and evaluated to determine the vehicle reference speed, wheel slip, wheel acceleration and other control values used for evaluating or modulating the brake pressure in the wheel brakes of the wheels being controlled or an intervention in the engine management, the method comprising the steps of:

increasing an engine control threshold or brake control threshold to a specified value after a gravel road has been identified, and predefining an engine control threshold in a range of 2 km/h to 10 km/h, or a brake control threshold in a range of 0 km/h to 10 km/h, wherein the brake control threshold is increased only when strongly overspeeding wheels are detected.

29. (New) Circuit arrangement for controlling a vehicle, using an anti-lock system (ABS), traction slip control (TCS) or driving-dynamics control system (ESP), comprising:

an identification circuit to identify a gravel road or a similar road with higher slip requirement,

a detection circuit for detecting the vibration behavior of the individual wheels is associated with the identification circuit, wherein the output of the detection circuit is connected to an input of an evaluation circuit for evaluating the detected vibration behavior, and wherein the identification circuit exhibits an integrator and a signal generator for generating a signal when a certain vibration behavior typical for gravel roads is detected on the wheels over a period of time predefined by the integrator with the help of the evaluation of the evaluation circuit.

30. (New) Circuit arrangement as claimed in claim 29, wherein a calculating circuit is associated with the identification circuit, which calculates the vehicle reference speed on the basis of measured values and whose output is connected to an input of a first comparator which is used for comparing the calculated vehicle reference speed with a specified limit value and is connected via an output to an input of the evaluation circuit which compares the detected vibration behavior of the individual wheels, in particular the period of vibration, with specified limit values; that the identification circuit exhibits a second comparator for comparing the wheel acceleration with a wheel acceleration limit value, a third comparator for comparing the vibration behavior of the individual wheels to one another, and a fourth comparator for comparing the traction slip of the wheels with a specified limit value; and that the signal generator is connected via an output to an input of a device used for intervening in the brake control or engine control when an appropriate signal for an identified driving situation on a gravel road is emitted.

REMARKS

Prior to a formal examination of the above-identified application, acceptance of the new claims and the enclosed substitute specification (under 37 CFR 1.125) is respectfully requested. It is believed that the substitute specification and new claims will facilitate processing of the application in accordance with M.P.E.P. 608.01(q). The substitute specification and new claims are in compliance with 37 CFR 1.52 (a and b) and, while

making no substantive changes, are submitted to conform this case to the formal requirements and long-established formal standards of U.S. Patent Office practice, and to provide improved idiom and better grammatical form.

The enclosed substitute specification is presented herein in both marked-up and clean versions.

STATEMENT

The undersigned, an attorney registered to practice before the office, hereby states that the enclosed substitute specification includes the same changes as are indicated in the mark-up copy of the original specification. The substitute specification contains no new subject matter.

Respectfully submitted,

Joseph V. Coppola, Sr.
Registration No. 33,373
Rader, Fishman and Grauer PLLC
39533 Woodward Ave., Suite 140
Bloomfield Hills, Michigan 48304
(248) 594-0650
Attorney for Applicants
CUSTOMER NO. 010291

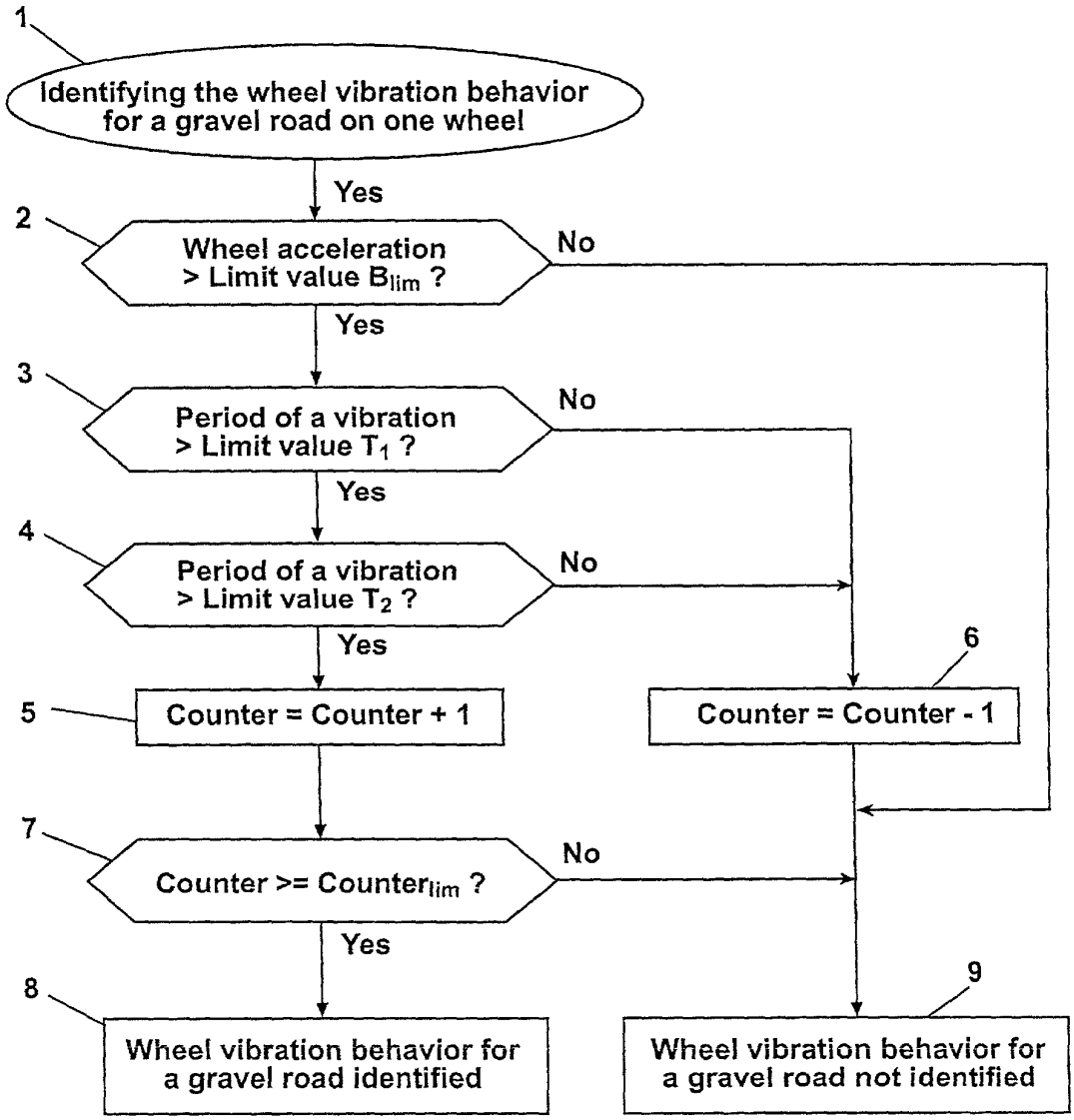

Fig. 1

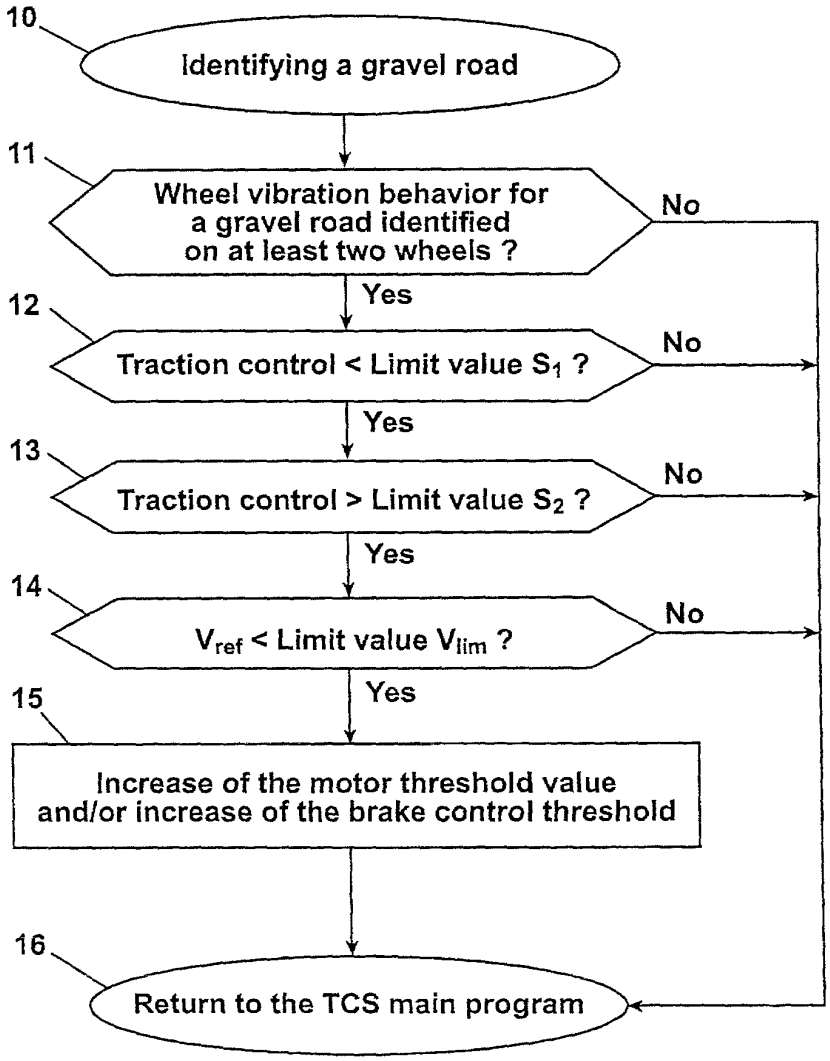
10
Identifying a gravel road
11
Wheel vibration behavior for a gravel road identified on at least two wheels ?
No
Yes
12
Traction control < Limit value S_1 ?
No
Yes
13
Traction control > Limit value S_2 ?
No
Yes
14
V_{ref} < Limit value V_{lim} ?
No
Yes
15
Increase of the motor threshold value and/or increase of the brake control threshold
16
Return to the TCS main program

Fig. 2

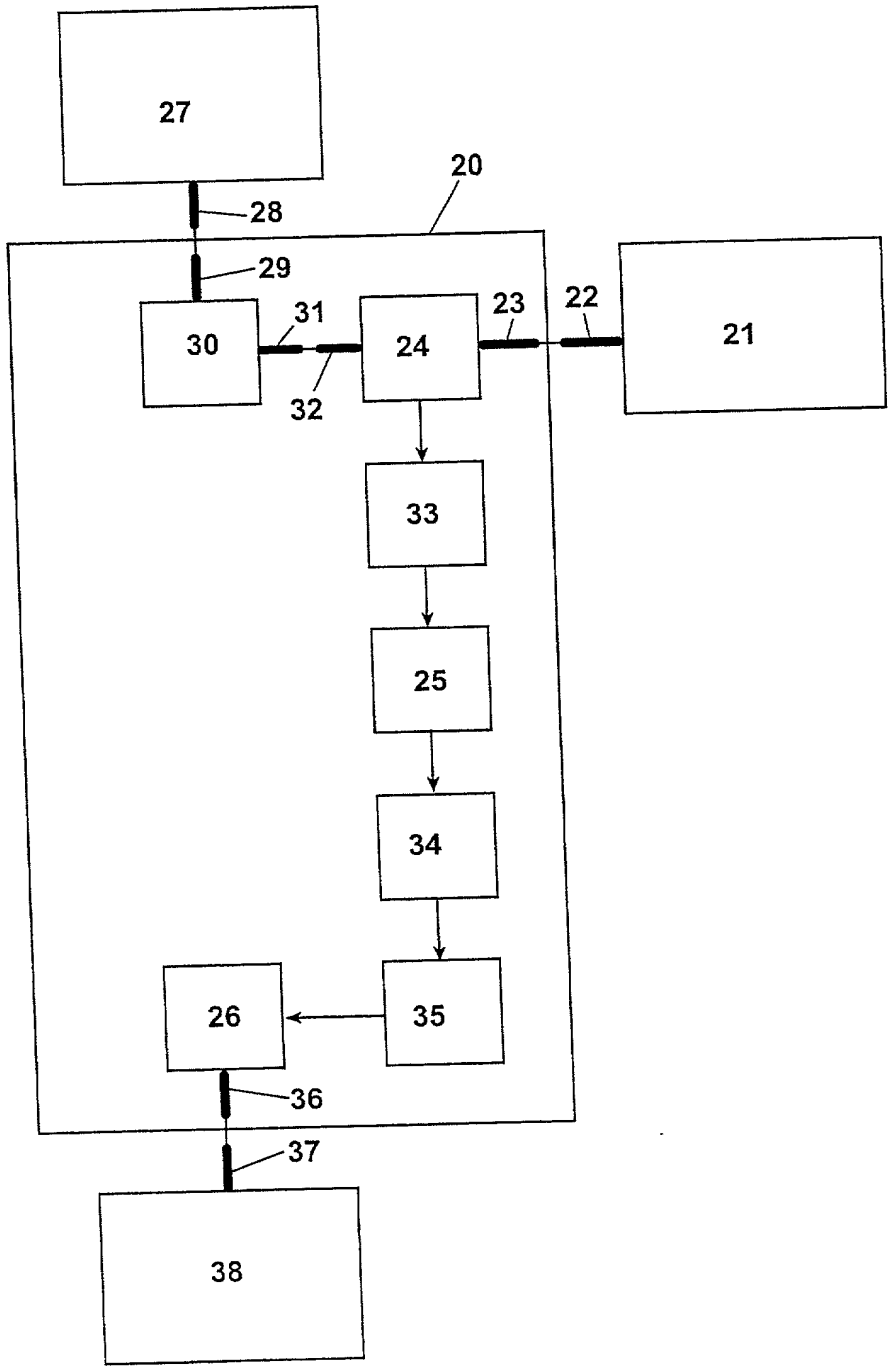

Fig. 3

SUBSTITUTE SPECIFICATION: CLEAN COPY

Method and Circuit Arrangement for Controlling a Vehicle

TECHNICAL FIELD

[0001] The present invention relates to a method and circuit for controlling a vehicle, wherein the rotation behavior of the individual wheels is measured and evaluated in order to determine the vehicle reference speed, wheel slip, wheel acceleration and other control values. These values are used for proportioning and/or modulating the brake pressure in the wheel brakes of the wheels being controlled and/or an intervention in the engine management.

BACKGROUND OF THE INVENTION

[0002] The methods for controlling a vehicle are designed to stabilize the vehicle in critical situations and to maintain its maneuverability. They are integrated in vehicle-control systems such as anti-lock systems (ABS), traction slip control (TCS) or driving-dynamics control systems (ESP). ABS prevents the wheels from blocking during braking operations. ESP, in its function as an overall system or superior system, ensures that the vehicle, particularly in a curve, does not exhibit instability, which would cause it to swerve sideways.

[0003] With the help of TCS, the build-up of brake pressure at the overspeeding drive wheels causes the wheel slip to be reduced to a value appropriate for ensuring the traction and driving stability. This system exists both for two-wheel drive and all-wheel drive vehicles. Besides the term TCS, such terms as "electronic differential lock" (EDS), traction slip control or traction (ASC or ASC+T), or "traction control system (TCS)" also are used. A differentiation should be made between two designs: TCS and brake-TCS. In certain situations TCS throttles the engine torque additionally by intervening in the engine

management in order to keep the load on the wheels as low as possible. Brake-TCS becomes effective exclusively through automatic brake intervention. In the description below, the term "TCS" refers to all feasible traction control systems, i.e., with and without intervention in the engine management.

[0004] In the prior art it already has been disclosed that the control response can be improved by detecting the vibrations of the drive train and changing the pressure modulation, e.g. in an active ABS control or active TCS control, in such a way that the wheel vibrations are not additionally increased, but rather dampened by a corresponding counter-phase modulation of the brake pressure in the wheel brakes. A prerequisite for this method is that the oscillations of the drive train and their resonant frequency is recognized.

[0005] For this purpose, the vehicle control system basically is designed for usage on roads characterized by an essentially smooth surface and, at least on the sides, an approximately equal friction value. A special problem in controlling a vehicle is a driving situation on a gravel road or a similar road with a higher slip requirement.

BRIEF SUMMARY OF THE INVENTION

[0006] An object of the present invention is to disclose a method and circuit for detecting a gravel road or a similar road with a higher slip requirement.

[0007] The object according to the invention is solved by a method characterized in that the vibration behavior of the individual wheels on the driven axle is detected and evaluated in order to identify a gravel road or a similar road with a higher slip requirement, and that the driving situation on a gravel road is considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration exceeds a specified

wheel acceleration limit value on at least two wheels and when these two wheels exhibit a certain vibration behavior.

[0008] According to the present invention, the term "gravel road" refers to roads characterized by irregularities and loose subsoil.

[0009] These types of road conditions lead to an increased slip requirement, with the term "increased slip requirement" within the scope of the present invention meaning that the longitudinal force (force in the radial direction of the tire to transmit the drive forces and, in the event of a braking operation, the brake forces) reaches its maximum with higher wheel-slip values. The slip requirement of a gravel road actually is higher than the slip requirement on packed snow.

[0010] An essential aspect of the method for controlling a vehicle according to the present invention is that, in addition to detecting the rotation behavior of the wheels, the vibration behavior of the individual wheels, especially the wheels on the driven axle, is detected and evaluated. The driving situation of a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration is greater than a specified limit value and when the wheels exhibit a certain vibration behavior. This means when certain vibration conditions characteristic of a gravel road are satisfied.

[0011] According to the present invention, the wheel acceleration limit value preferably is specified within a range of 1g to 2g, in particular about 1.5.

[0012] According to the present invention, a prerequisite for identifying a gravel road is that a specified period of the vibrations on at least two driven wheels is detected, with such period lying within a specified period range, preferably within a range of 30 msec. to 150 msec, or the detection of a

specified period of the vibrations on at least two driven wheels, which reaches a specified limit value, preferably about 50 msec.

[0013] The period of the vibrations advantageously should be detected over a certain period of time in order to definitely detect a period. This period of time preferably should be 30 msec. to 150 msec., in particular about 50 msec. This means that generally the detection of a period of a vibration is sufficient for detecting a gravel road.

[0014] According to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the driven wheels exhibit a specified traction slip, in particular a traction slip in the range of 0 km/h to 50 km/h.

[0015] In the method according to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the calculated or estimated vehicle reference speed falls below a specified vehicle speed limit value, which advantageously lies within a range of 60 km/h to 100 km/h and preferably is about 80 km/h.

[0016] According to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the above-mentioned conditions for a gravel road were identified for both wheels on one side of the vehicle and/or one vehicle axle of a vehicle with all-wheel drive, or when the above-mentioned conditions for a gravel road were identified for both wheels on the driven axle of a vehicle with one driven axle.

[0017] Within the meaning of the invention, the term "vehicle with all-wheel drive" comprises both vehicles with at least four permanently driven wheels on at least two driven axles as well as vehicles driven primarily by one axle, in which a second axle can be added when necessary. This can occur manually or automatically, for example with the aid of a viscous clutch.

[0018] When a gravel road has been identified, especially according to the method described above, an engine control threshold is increased, as disclosed in the present invention, preferably to a value within a range of 2 km/h to 10 km/h, especially preferred about 3 km/h, and/or a brake control threshold is increased, preferably within a range of 0 km/h to 10 km/h, especially advantageously about 3 km/h.

[0019] In this context, the term "engine control threshold" means the wheel slip that needs to be set by the engine control to achieve the best possible compromise between traction and driving stability, in particular TCS engine control. Within the meaning of the invention, the term "brake control threshold" refers to the wheel slip that needs to be set by the brake control to achieve the best possible compromise between traction and driving stability, in particular TCS brake control.

[0020] According to the present invention, the brake control threshold is increased only when certain driving situations are identified, e.g. highly overspeeding wheels, e.g. in terrain with large wheel-load fluctuations or under μ-split conditions.

[0021] Furthermore, the object of the invention is solved by means of a circuit for controlling a vehicle, such as an anti-lock system (ABS), traction slip control system (TCS) or driving-dynamics control system (ESP), which is characterized in that it exhibits an identification circuit for identifying a gravel road or a similar road with a higher slip requirement. A

detection circuit for detecting the vibration behavior of the individual wheels is associated with such identification circuit. The output of the detection circuit is connected to the input of an evaluation circuit in order to evaluate the detected vibration behavior. The identification circuit exhibits an integrator and signal generator to generate a signal when a certain vibration behavior of the wheels typical for gravel roads is detected over a period of time predefined by the integrator with the help of the evaluation of the evaluation circuit.

[0022] The detection circuit preferably exhibits comparators for the wheel acceleration as well as extreme-value detectors to detect the vibration behavior of the individual wheels.

[0023] In accordance with an embodiment of the present invention, the circuit is characterized in that a calculating circuit is associated with the identification circuit in order to calculate a vehicle reference speed on the basis of measured values, and the output of the calculating circuit is connected to an input of a first comparator which serves to compare the calculated vehicle reference speed with a predefined limit value, and this first comparator is connected via an output to an input of the evaluating circuit, and the evaluating circuit compares the detected vibration behavior of the individual wheels, in particular the period of a vibration, with the specified limit values; that the identification circuit exhibits a second comparator for comparing the wheel acceleration with a wheel acceleration limit value, a third comparator for comparing the vibration behavior of the individual wheels to one another, and a fourth comparator for comparing the traction slip of the wheels with a specified limit value; and that an output of the signal generator is connected to an input of a device used for intervening in the brake control and/or engine control when an appropriate signal for an identified driving situation on a gravel road is emitted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Figure 1 shows a flow diagram of an embodiment of the method for detecting the wheel vibration behavior for a gravel road on one wheel according to the invention.

[0025] Figure 2 shows a flow diagram of an embodiment of the method for detecting a gravel road according to the invention.

[0026] Figure 3 is a block diagram of an embodiment of the circuit for detecting a gravel road according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] As shown in Figure 1, wheel acceleration by means of query 2 is required as a basic condition for detecting the vibration behavior for a gravel road on a wheel at the beginning after the start (step 1), with such wheel acceleration lying above a wheel acceleration limit value (B_{lim}), e.g. above 1g. Then it is checked whether the individual wheels exhibit vibration behavior characteristic of a gravel road. For this purpose - if the wheel acceleration limit value (B_{lim}) is exceeded - the period of time between the maximum points of a period of vibration is determined and query steps 3 and 4 check whether the period of vibrations on the wheel lie within a specified range that is defined by an upper limit value (T_1) (step 3) and a lower limit value (T_2) (step 4). The interval defined by the upper limit value (T_1) and lower limit value (T_2) is set depending on the dynamics and vibration behavior of the drive train of the vehicle and the road surface to be detected. When these conditions are satisfied, an integrator associated with the wheel being observed is incremented in a specified period of time. For this purpose, a counter associated with the wheel concerned is increased by 1 respectively in step 5. If this is not the case, then the counter is reduced by 1 respectively in step 6. The value can

be decremented to zero (0) in this way. If, on the other hand, the counter exceeds a threshold value ($COUNTER_{lim}$) (step 7), the conditions for a gravel road have been detected for the wheel concerned (step 8). In the other case, if the conditions of steps 2 or 3 or 4 or 7 were not satisfied, the vibration conditions for a gravel road will not be considered to have been identified on the wheel (step 9).

[0028] After the detection or non-detection of vibration conditions for a gravel road on one wheel (step 8 or 9) shown in Figure 1, the driving situation of a gravel road is determined advantageously according to the flow diagram in Figure 2 (beginning step 10). For this purpose, the vibration behavior determined on the individual wheels is compared. If the vibration behavior for a gravel road was identified on at least two wheels (step 11) and if the traction slip lies within a specified range, i.e. below a first limit value (S_1), e.g. 50 km/h (step 12), and above a second limit value (S_2), e.g. 0 km/h (step 13), the query continues to step 14. In step 14 it is queried whether the vehicle reference speed (V_{ref}) lies below a speed threshold (V_{lim}), e.g. below 80 km/h. If this applies, the driving situation of a gravel road will be considered to have been identified and a corresponding control function of the vehicle control system can be activated. For example, this could mean increasing the engine control threshold and/or the brake control threshold (step 15). In all other cases, if the conditions of the queries in steps 11 or 12 or 13 or 14 are not satisfied, a reset to the main program of the control system, e.g. an TCS, occurs (step 16).

[0029] According to the invention, all previously described steps can be realized advantageously by means of corresponding program steps of a software program or a sub-program within a vehicle control system, in particular traction slip control (TCS).

[0030] However, the steps also can be realized with the aid of a circuit arrangement. The block diagram in Figure 3 illustrates such a circuit arrangement, which, by way of example, shows the essential electric/electronic components of an embodiment for detecting a gravel road.

[0031] An essential element of the invention is the identification circuit (20). A detection circuit (21) for detecting the vibration behavior on the individual wheels is associated with the identification circuit (20), and the output (22) of the detection circuit (21) is connected to an input (23) of an evaluation circuit (24) for evaluating the detected vibration behavior. The identification circuit (20) exhibits an integrator (25) and signal generator (26) for generating a signal when a certain vibration behavior typical for gravel roads is detected on the wheels over a period of time predefined by the integrator (25) with the help of the evaluation of the evaluation circuit (23). In addition, a calculating circuit (27) for calculating a vehicle reference speed (V_{ref}) on the basis of measured values is associated with the identification circuit (20). An output (28) of the calculating circuit (27) is connected to an input (29) of a first comparator (30), which serves to compare the calculated vehicle reference speed (V_{ref}) with a specified limit value (V_{lim}); and this first comparator (30) is connected via an output (31) to an input (32) of the evaluation circuit (23), which compares the detected vibration behavior of the individual wheels, in particular the period of a vibration, with specified limit values (T_1, T_2). The identification circuit (20) exhibits a second comparator (33) used for comparing the wheel acceleration with a wheel acceleration limit value (B_{lim}), a third comparator (34) for comparing the vibration behavior of the individual wheels to one another, and a fourth comparator (35) for comparing the traction slip of the wheels with a specified limit value (S_1, S_2). The signal generator (26) is connected via an output (36) to an input (37) of a device (38) used for intervening in the brake control

and/or engine control when an appropriate signal for an identified driving situation on a gravel road is emitted.

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Method and Circuit Arrangement for Controlling a Vehicle

ABSTRACT OF THE DISCLOSURE

[0032] The invention relates to a method for controlling a vehicle, in which the rotation behavior of the individual wheels is measured and evaluated to determine the control values that are to be used for proportioning and/or modulating the brake pressure in the wheel brakes of the wheels being controlled and/or for an intervention in the engine management, wherein the vibration behavior of the individual wheels, particularly the wheels on the driven axle, is detected and evaluated in order to identify a gravel road or a similar road with a higher slip requirement. The driving situation of a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration on at least two wheels exceeds a predefined wheel acceleration limit value and these two wheels exhibit a certain vibration behavior.

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Method and Circuit Arrangement for Controlling a Vehicle

TECHNICAL FIELD

The present invention relates to a method and circuit for controlling a vehicle, wherein the rotation behavior of the individual wheels is measured and evaluated in order to determine the vehicle reference speed, wheel slip, wheel acceleration and other control values. These values are used for proportioning and/or modulating the brake pressure in the wheel brakes of the wheels being controlled and/or an intervention in the engine management.

BACKGROUND OF THE INVENTION

The methods for controlling a vehicle are designed to stabilize the vehicle in critical situations and to maintain its maneuverability. They are integrated in vehicle-control systems such as anti-lock systems (ABS), traction slip control (TCS) or driving-dynamics control systems (ESP). ABS prevents the wheels from blocking during braking operations. ESP, in its function as an overall system or superior system, ensures that the vehicle, particularly in a curve, does not exhibit instability, which would cause it to swerve sideways.

With the help of TCS, the build-up of brake pressure at the overspeeding drive wheels causes the wheel slip to be reduced to a value appropriate for ensuring the traction and driving stability. This system exists both for two-wheel drive and all-wheel drive vehicles. Besides the term TCS, such terms as [„electronic differential lock"] "electronic differential lock" (EDS), traction slip control or traction (ASC or ASC+T), or [„traction control system (TCS)"] "traction control system

(TCS)" also are used. A differentiation should be made between two designs: TCS and brake-TCS. In certain situations TCS throttles the engine torque additionally by intervening in the engine management in order to keep the load on the wheels as low as possible. Brake-TCS becomes effective exclusively through automatic brake intervention. In the description below, the term [„TCS"] "TCS" refers to all feasible traction control systems, i.e., with and without intervention in the engine management.

In the prior art it already has been disclosed that the control response can be improved by detecting the vibrations of the drive train and changing the pressure modulation, e.g. in an active ABS control or active TCS control, in such a way that the wheel vibrations are not additionally increased, but rather dampened by a corresponding counter-phase modulation of the brake pressure in the wheel brakes. A prerequisite for this method is that the oscillations of the drive train and their resonant frequency is recognized.

For this purpose, the vehicle control system basically is designed for usage on roads characterized by an essentially smooth surface and, at least on the sides, an approximately equal friction value. A special problem in controlling a vehicle is a driving situation on a gravel road or a similar road with a higher slip requirement.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to disclose a method and circuit for detecting a gravel road or a similar road with a higher slip requirement.

The object according to the invention is solved by a method characterized in that the vibration behavior of the individual wheels on the driven axle is detected and evaluated in order to identify a gravel road or a similar road with a higher slip requirement, and that the driving situation on a gravel road is considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration exceeds a specified wheel acceleration limit value on at least two wheels and when these two wheels exhibit a certain vibration behavior.

According to the present invention, the term [„gravel road"] "gravel road" refers to roads characterized by irregularities and loose subsoil.

These types of road conditions lead to an increased slip requirement, with the term [„increased slip requirement"] "increased slip requirement" within the scope of the present invention meaning that the longitudinal force (force in the radial direction of the tire to transmit the drive forces and, in the event of a braking operation, the brake forces) reaches its maximum with higher wheel-slip values. The slip requirement of a gravel road actually is higher than the slip requirement on packed snow.

An essential aspect of the method for controlling a vehicle according to the present invention is that, in addition to detecting the rotation behavior of the wheels, the vibration behavior of the individual wheels, especially the wheels on the driven axle, is detected and evaluated. The driving situation of a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration is greater than a specified limit value and when

the wheels exhibit a certain vibration behavior. This means when certain vibration conditions characteristic of a gravel road are satisfied.

According to the present invention, the wheel acceleration limit value preferably is specified within a range of 1g to 2g, in particular about 1.5.

According to the present invention, a prerequisite for identifying a gravel road is that a specified period of the vibrations on at least two driven wheels is detected, with such period lying within a specified period range, preferably within a range of 30 msec. to 150 msec, or the detection of a specified period of the vibrations on at least two driven wheels, which reaches a specified limit value, preferably about 50 msec.

The period of the vibrations advantageously should be detected over a certain period of time in order to definitely detect a period. This period of time preferably should be 30 msec. to 150 msec., in particular about 50 msec. This means that generally the detection of a period of a vibration is sufficient for detecting a gravel road.

According to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the driven wheels exhibit a specified traction slip, in particular a traction slip in the range of 0 km/h to 50 km/h.

In the method according to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system

is only activated when the calculated or estimated vehicle reference speed falls below a specified vehicle speed limit value, which advantageously lies within a range of 60 km/h to 100 km/h and preferably is about 80 km/h.

According to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the above-mentioned conditions for a gravel road were identified for both wheels on one side of the vehicle and/or one vehicle axle of a vehicle with all-wheel drive, or when the above-mentioned conditions for a gravel road were identified for both wheels on the driven axle of a vehicle with one driven axle.

Within the meaning of the invention, the term [„vehicle with all-wheel drive"] "vehicle with all-wheel drive" comprises both vehicles with at least four permanently driven wheels on at least two driven axles as well as vehicles driven primarily by one axle, in which a second axle can be added when necessary. This can occur manually or automatically, for example with the aid of a viscous clutch.

When a gravel road has been identified, especially according to the method described above, an engine control threshold is increased, as disclosed in the present invention, preferably to a value within a range of 2 km/h to 10 km/h, especially preferred about 3 km/h, and/or a brake control threshold is increased, preferably within a range of 0 km/h to 10 km/h, especially advantageously about 3 km/h.

In this context, the term [„engine control threshold"] "engine control threshold" means the wheel slip that needs to be set by the engine control to achieve the best possible compromise

between traction and driving stability, in particular TCS engine control. Within the meaning of the invention, the term [„brake control threshold"] "brake control threshold" refers to the wheel slip that needs to be set by the brake control to achieve the best possible compromise between traction and driving stability, in particular TCS brake control.

According to the present invention, the brake control threshold is increased only when certain driving situations are identified, e.g. highly overspeeding wheels, e.g. in terrain with large wheel-load fluctuations or under μ-split conditions.

Furthermore, the object of the invention is solved by means of a circuit for controlling a vehicle, such as an anti-lock system (ABS), traction slip control system (TCS) or driving-dynamics control system (ESP), which is characterized in that it exhibits an identification circuit for identifying a gravel road or a similar road with a higher slip requirement. A detection circuit for detecting the vibration behavior of the individual wheels is associated with such identification circuit. The output of the detection circuit is connected to the input of an evaluation circuit in order to evaluate the detected vibration behavior. The identification circuit exhibits an integrator and signal generator to generate a signal when a certain vibration behavior of the wheels typical for gravel roads is detected over a period of time predefined by the integrator with the help of the evaluation of the evaluation circuit.

The detection circuit preferably exhibits comparators for the wheel acceleration as well as extreme-value detectors to detect the vibration behavior of the individual wheels.

In accordance with an embodiment of the present invention, the circuit is characterized in that a calculating circuit is associated with the identification circuit in order to calculate a vehicle reference speed on the basis of measured values, and the output of the calculating circuit is connected to an input of a first comparator which serves to compare the calculated vehicle reference speed with a predefined limit value, and this first comparator is connected via an output to an input of the evaluating circuit, and the evaluating circuit compares the detected vibration behavior of the individual wheels, in particular the period of a vibration, with the specified limit values; that the identification circuit exhibits a second comparator for comparing the wheel acceleration with a wheel acceleration limit value, a third comparator for comparing the vibration behavior of the individual wheels to one another, and a fourth comparator for comparing the traction slip of the wheels with a specified limit value; and that an output of the signal generator is connected to an input of a device used for intervening in the brake control and/or engine control when an appropriate signal for an identified driving situation on a gravel road is emitted.

[The invention will be explained in more detail on the basis of two flow diagrams (Figure 1 and Figure 2) and a block diagram (Figure 3) below.]

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a flow diagram of an embodiment of the method for detecting the wheel vibration behavior for a gravel road on one wheel according to the invention.

Figure 2 shows a flow diagram of an embodiment of the method for detecting a gravel road according to the invention.

Figure 3 is a block diagram of an embodiment of the circuit for detecting a gravel road according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figure 1, wheel acceleration by means of query 2 is required as a basic condition for detecting the vibration behavior for a gravel road on a wheel at the beginning after the start (step 1), with such wheel acceleration lying above a wheel acceleration limit value (B_{lim}), e.g. above 1g. Then it is checked whether the individual wheels exhibit vibration behavior characteristic of a gravel road. For this purpose - if the wheel acceleration limit value (B_{lim}) is exceeded - the period of time between the maximum points of a period of vibration is determined and query steps 3 and 4 check whether the period of vibrations on the wheel lie within a specified range that is defined by an upper limit value (T_1) (step 3) and a lower limit value (T_2) (step 4). The interval defined by the upper limit value (T_1) and lower limit value (T_2) is set depending on the dynamics and vibration behavior of the drive train of the vehicle and the road surface to be detected. When these conditions are satisfied, an integrator associated with the wheel being observed is incremented in a specified period of time. For this purpose, a counter associated with the wheel concerned is increased by 1 respectively in step 5. If this is not the case, then the counter is reduced by 1 respectively in step 6. The value can be decremented to zero (0) in this way. If, on the other hand, the counter exceeds a threshold value ($COUNTER_{lim}$) (step 7), the conditions for a gravel road have been detected for the wheel concerned (step 8). In the other case, if the conditions of steps 2 or 3 or 4 or 7 were not

satisfied, the vibration conditions for a gravel road will not be considered to have been identified on the wheel (step 9).

After the detection or non-detection of vibration conditions for a gravel road on one wheel (step 8 or 9) shown in Figure 1, the driving situation of a gravel road is determined advantageously according to the flow diagram in Figure 2 (beginning step 10). For this purpose, the vibration behavior determined on the individual wheels is compared. If the vibration behavior for a gravel road was identified on at least two wheels (step 11) and if the traction slip lies within a specified range, i.e. below a first limit value (S_1), e.g. 50 km/h (step 12), and above a second limit value (S_2), e.g. 0 km/h (step 13), the query continues to step 14. In step 14 it is queried whether the vehicle reference speed (V_{ref}) lies below a speed threshold (V_{lim}), e.g. below 80 km/h. If this applies, the driving situation of a gravel road will be considered to have been identified and a corresponding control function of the vehicle control system can be activated. For example, this could mean increasing the engine control threshold and/or the brake control threshold (step 15). In all other cases, if the conditions of the queries in steps 11 or 12 or 13 or 14 are not satisfied, a reset to the main program of the control system, e.g. an TCS, occurs (step 16).

According to the invention, all previously described steps can be realized advantageously by means of corresponding program steps of a software program or a sub-program within a vehicle control system, in particular traction slip control (TCS).

However, the steps also can be realized with the aid of a circuit arrangement. The block diagram in Figure 3 illustrates such a circuit arrangement, which, by way of example, shows

the essential electric/electronic components of an embodiment for detecting a gravel road.

An essential element of the invention is the identification circuit (20). A detection circuit (21) for detecting the vibration behavior on the individual wheels is associated with the identification circuit (20), and the output (22) of the detection circuit (21) is connected to an input (23) of an evaluation circuit (24) for evaluating the detected vibration behavior. The identification circuit (20) exhibits an integrator (25) and signal generator (26) for generating a signal when a certain vibration behavior typical for gravel roads is detected on the wheels over a period of time predefined by the integrator (25) with the help of the evaluation of the evaluation circuit (23). In addition, a calculating circuit (27) for calculating a vehicle reference speed (V_{ref}) on the basis of measured values is associated with the identification circuit (20). An output (28) of the calculating circuit (27) is connected to an input (29) of a first comparator (30), which serves to compare the calculated vehicle reference speed (V_{ref}) with a specified limit value (V_{lim}); and this first comparator (30) is connected via an output (31) to an input (32) of the evaluation circuit (23), which compares the detected vibration behavior of the individual wheels, in particular the period of a vibration, with specified limit values (T_1, T_2). The identification circuit (20) exhibits a second comparator (33) used for comparing the wheel acceleration with a wheel acceleration limit value (B_{lim}), a third comparator (34) for comparing the vibration behavior of the individual wheels to one another, and a fourth comparator (35) for comparing the traction slip of the wheels with a specified limit value (S_1, S_2). The signal generator (26) is connected via an output (36) to an input (37) of a device (38) used for intervening in the brake

control and/or engine control when an appropriate signal for an identified driving situation on a gravel road is emitted.

AP 9671

[Abstract]

Method and Circuit Arrangement for Controlling a Vehicle

ABSTRACT OF THE DISCLOSURE

The invention relates to a method for controlling a vehicle, in which the rotation behavior of the individual wheels is measured and evaluated to determine the control values that are to be used for proportioning and/or modulating the brake pressure in the wheel brakes of the wheels being controlled and/or for an intervention in the engine management, wherein the vibration behavior of the individual wheels, particularly the wheels on the driven axle, is detected and evaluated in order to identify a gravel road or a similar road with a higher slip requirement. The driving situation of a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration on at least two wheels exceeds a predefined wheel acceleration limit value and these two wheels exhibit a certain vibration behavior.

[(Figure 1)]

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Method and Circuit Arrangement for Controlling a Vehicle

The present invention relates to a method and circuit for controlling a vehicle, wherein the rotation behavior of the individual wheels is measured and evaluated in order to determine the vehicle reference speed, wheel slip, wheel acceleration and other control values. These values are used for proportioning and/or modulating the brake pressure in the wheel brakes of the wheels being controlled and/or an intervention in the engine management.

The methods for controlling a vehicle are designed to stabilize the vehicle in critical situations and to maintain its maneuverability. They are integrated in vehicle-control systems such as anti-lock systems (ABS), traction slip control (TCS) or driving-dynamics control systems (ESP). ABS prevents the wheels from blocking during braking operations. ESP, in its function as an overall system or superior system, ensures that the vehicle, particularly in a curve, does not exhibit instability, which would cause it to swerve sideways.

With the help of TCS, the build-up of brake pressure at the overspeeding drive wheels causes the wheel slip to be reduced to a value appropriate for ensuring the traction and driving stability. This system exists both for two-wheel drive and all-wheel drive vehicles. Besides the term TCS, such terms as „electronic differential lock" (EDS), traction slip control or traction (ASC or ASC+T), or „traction control system (TCS)" also are used. A differentiation should be made between two designs: TCS and brake-TCS. In certain situations TCS throttles the engine torque additionally by intervening in the engine management in order to keep the load on the wheels as low as

possible. Brake-TCS becomes effective exclusively through automatic brake intervention. In the description below, the term „TCS" refers to all feasible traction control systems, i.e., with and without intervention in the engine management.

In the prior art it already has been disclosed that the control response can be improved by detecting the vibrations of the drive train and changing the pressure modulation, e.g. in an active ABS control or active TCS control, in such a way that the wheel vibrations are not additionally increased, but rather dampened by a corresponding counter-phase modulation of the brake pressure in the wheel brakes. A prerequisite for this method is that the oscillations of the drive train and their resonant frequency is recognized.

For this purpose, the vehicle control system basically is designed for usage on roads characterized by an essentially smooth surface and, at least on the sides, an approximately equal friction value. A special problem in controlling a vehicle is a driving situation on a gravel road or a similar road with a higher slip requirement.

Therefore, it is the object of the present invention to disclose a method and circuit for detecting a gravel road or a similar road with a higher slip requirement.

The object according to the invention is solved by a method characterized in that the vibration behavior of the individual wheels on the driven axle is detected and evaluated in order to identify a gravel road or a similar road with a higher slip requirement, and that the driving situation on a gravel road is considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration exceeds a specified wheel acceleration limit value on at least two wheels and when these two wheels exhibit a certain vibration behavior.

According to the present invention, the term „gravel road" refers to roads characterized by irregularities and loose subsoil.

These types of road conditions lead to an increased slip requirement, with the term „increased slip requirement" within the scope of the present invention meaning that the longitudinal force (force in the radial direction of the tire to transmit the drive forces and, in the event of a braking operation, the brake forces) reaches its maximum with higher wheel-slip values. The slip requirement of a gravel road actually is higher than the slip requirement on packed snow.

An essential aspect of the method for controlling a vehicle according to the present invention is that, in addition to detecting the rotation behavior of the wheels, the vibration behavior of the individual wheels, especially the wheels on the driven axle, is detected and evaluated. The driving situation of a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration is greater than a specified limit value and when the wheels exhibit a certain vibration behavior. This means when certain vibration conditions characteristic of a gravel road are satisfied.

According to the present invention, the wheel acceleration limit value preferably is specified within a range of 1g to 2g, in particular about 1.5.

According to the present invention, a prerequisite for identifying a gravel road is that a specified period of the vibrations on at least two driven wheels is detected, with such period lying within a specified period range, preferably within a range of 30 msec. to 150 msec, or the detection of a specified period of the vibrations on at least two driven wheels, which reaches a specified limit value, preferably about 50 msec.

The period of the vibrations advantageously should be detected over a certain period of time in order to definitely detect a period. This period of time preferably should be 30 msec. to 150 msec., in particular about 50 msec. This means that generally the detection of a period of a vibration is sufficient for detecting a gravel road.

According to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the driven wheels exhibit a specified traction slip, in particular a traction slip in the range of 0 km/h to 50 km/h.

In the method according to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the calculated or estimated vehicle reference speed falls below a specified vehicle speed limit value, which advantageously lies within a range of 60 km/h to 100 km/h and preferably is about 80 km/h.

According to the present invention, a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the above-mentioned conditions for a gravel road were identified for both wheels on one side of the vehicle and/or one vehicle axle of a vehicle with all-wheel drive, or when the above-mentioned conditions for a gravel road were identified for both wheels on the driven axle of a vehicle with one driven axle.

Within the meaning of the invention, the term „vehicle with all-wheel drive" comprises both vehicles with at least four permanently driven wheels on at least two driven axles as well as vehicles driven primarily by one axle, in which a second

axle can be added when necessary. This can occur manually or automatically, for example with the aid of a viscous clutch.

When a gravel road has been identified, especially according to the method described above, an engine control threshold is increased, as disclosed in the present invention, preferably to a value within a range of 2 km/h to 10 km/h, especially preferred about 3 km/h, and/or a brake control threshold is increased, preferably within a range of 0 km/h to 10 km/h, especially advantageously about 3 km/h.

In this context, the term „engine control threshold“ means the wheel slip that needs to be set by the engine control to achieve the best possible compromise between traction and driving stability, in particular TCS engine control. Within the meaning of the invention, the term „brake control threshold“ refers to the wheel slip that needs to be set by the brake control to achieve the best possible compromise between traction and driving stability, in particular TCS brake control.

According to the present invention, the brake control threshold is increased only when certain driving situations are identified, e.g. highly overspeeding wheels, e.g. in terrain with large wheel-load fluctuations or under ì-split conditions.

Furthermore, the object of the invention is solved by means of a circuit for controlling a vehicle, such as an anti-lock system (ABS), traction slip control system (TCS) or driving-dynamics control system (ESP), which is characterized in that it exhibits an identification circuit for identifying a gravel road or a similar road with a higher slip requirement. A detection circuit for detecting the vibration behavior of the individual wheels is associated with such identification circuit. The output of the detection circuit is connected to the input of an evaluation circuit in order to evaluate the detected vibration behavior. The identification circuit

exhibits an integrator and signal generator to generate a signal when a certain vibration behavior of the wheels typical for gravel roads is detected over a period of time predefined by the integrator with the help of the evaluation of the evaluation circuit.

The detection circuit preferably exhibits comparators for the wheel acceleration as well as extreme-value detectors to detect the vibration behavior of the individual wheels.

In accordance with an embodiment of the present invention, the circuit is characterized in that a calculating circuit is associated with the identification circuit in order to calculate a vehicle reference speed on the basis of measured values, and the output of the calculating circuit is connected to an input of a first comparator which serves to compare the calculated vehicle reference speed with a predefined limit value, and this first comparator is connected via an output to an input of the evaluating circuit, and the evaluating circuit compares the detected vibration behavior of the individual wheels, in particular the period of a vibration, with the specified limit values; that the identification circuit exhibits a second comparator for comparing the wheel acceleration with a wheel acceleration limit value, a third comparator for comparing the vibration behavior of the individual wheels to one another, and a fourth comparator for comparing the traction slip of the wheels with a specified limit value; and that an output of the signal generator is connected to an input of a device used for intervening in the brake control and/or engine control when an appropriate signal for an identified driving situation on a gravel road is emitted.

The invention will be explained in more detail on the basis of two flow diagrams (Figure 1 and Figure 2) and a block diagram (Figure 3) below.

Figure 1 shows a flow diagram of an embodiment of the method for detecting the wheel vibration behavior for a gravel road on one wheel according to the invention.

Figure 2 shows a flow diagram of an embodiment of the method for detecting a gravel road according to the invention.

Figure 3 is a block diagram of an embodiment of the circuit for detecting a gravel road according to the invention.

As shown in Figure 1, wheel acceleration by means of query 2 is required as a basic condition for detecting the vibration behavior for a gravel road on a wheel at the beginning after the start (step 1), with such wheel acceleration lying above a wheel acceleration limit value (B_{lim}), e.g. above 1g. Then it is checked whether the individual wheels exhibit vibration behavior characteristic of a gravel road. For this purpose - if the wheel acceleration limit value (B_{lim}) is exceeded - the period of time between the maximum points of a period of vibration is determined and query steps 3 and 4 check whether the period of vibrations on the wheel lie within a specified range that is defined by an upper limit value (T_1) (step 3) and a lower limit value (T_2) (step 4). The interval defined by the upper limit value (T_1) and lower limit value (T_2) is set depending on the dynamics and vibration behavior of the drive train of the vehicle and the road surface to be detected. When these conditions are satisfied, an integrator associated with the wheel being observed is incremented in a specified period of time. For this purpose, a counter associated with the wheel concerned is increased by 1 respectively in step 5. If this is not the case, then the counter is reduced by 1 respectively in step 6. The value can be decremented to zero (0) in this way. If, on the other hand, the counter exceeds a threshold value ($COUNTER_{lim}$) (step 7), the conditions for a gravel road have been detected for the wheel concerned (step 8). In the other case, if the conditions of steps 2 or 3 or 4 or 7 were not

satisfied, the vibration conditions for a gravel road will not be considered to have been identified on the wheel (step 9).

After the detection or non-detection of vibration conditions for a gravel road on one wheel (step 8 or 9) shown in Figure 1, the driving situation of a gravel road is determined advantageously according to the flow diagram in Figure 2 (beginning step 10). For this purpose, the vibration behavior determined on the individual wheels is compared. If the vibration behavior for a gravel road was identified on at least two wheels (step 11) and if the traction slip lies within a specified range, i.e. below a first limit value (S_1), e.g. 50 km/h (step 12), and above a second limit value (S_2), e.g. 0 km/h (step 13), the query continues to step 14. In step 14 it is queried whether the vehicle reference speed (V_{ref}) lies below a speed threshold (V_{lim}), e.g. below 80 km/h. If this applies, the driving situation of a gravel road will be considered to have been identified and a corresponding control function of the vehicle control system can be activated. For example, this could mean increasing the engine control threshold and/or the brake control threshold (step 15). In all other cases, if the conditions of the queries in steps 11 or 12 or 13 or 14 are not satisfied, a reset to the main program of the control system, e.g. an TCS, occurs (step 16).

According to the invention, all previously described steps can be realized advantageously by means of corresponding program steps of a software program or a sub-program within a vehicle control system, in particular traction slip control (TCS).

However, the steps also can be realized with the aid of a circuit arrangement. The block diagram in Figure 3 illustrates such a circuit arrangement, which, by way of example, shows the essential electric/electronic components of an embodiment for detecting a gravel road.

An essential element of the invention is the identification circuit (20). A detection circuit (21) for detecting the vibration behavior on the individual wheels is associated with the identification circuit (20), and the output (22) of the detection circuit (21) is connected to an input (23) of an evaluation circuit (24) for evaluating the detected vibration behavior. The identification circuit (20) exhibits an integrator (25) and signal generator (26) for generating a signal when a certain vibration behavior typical for gravel roads is detected on the wheels over a period of time predefined by the integrator (25) with the help of the evaluation of the evaluation circuit (23). In addition, a calculating circuit (27) for calculating a vehicle reference speed (V_{ref}) on the basis of measured values is associated with the identification circuit (20). An output (28) of the calculating circuit (27) is connected to an input (29) of a first comparator (30), which serves to compare the calculated vehicle reference speed (V_{ref}) with a specified limit value (V_{lim}); and this first comparator (30) is connected via an output (31) to an input (32) of the evaluation circuit (23), which compares the detected vibration behavior of the individual wheels, in particular the period of a vibration, with specified limit values (T_1, T_2). The identification circuit (20) exhibits a second comparator (33) used for comparing the wheel acceleration with a wheel acceleration limit value (B_{lim}), a third comparator (34) for comparing the vibration behavior of the individual wheels to one another, and a fourth comparator (35) for comparing the traction slip of the wheels with a specified limit value (S_1, S_2). The signal generator (26) is connected via an output (36) to an input (37) of a device (38) used for intervening in the brake control and/or engine control when an appropriate signal for an identified driving situation on a gravel road is emitted.

Patent Claims

1. A method for controlling a vehicle, wherein the rotation behavior of the individual wheels is measured and evaluated in order to determine the vehicle reference speed, wheel slip, wheel acceleration and other control values used for proportioning and/or modulating the brake pressure in the wheel brakes of the wheels being controlled and/or for an intervention in the engine management, **characterized in that,** in order to identify a gravel road or similar road with a higher slip requirement, the vibration behavior of the individual wheels on the driven axle is detected and evaluated, and in that the driving situation of a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the wheel acceleration on at least two wheels exceeds a specified wheel acceleration limit value (B_{lim}) and when the at least two wheels exhibit a certain vibration behavior.

2. Method according to Claim 1, **characterized in that** a gravel road is considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the period of a vibration on at least two driven wheels lies within a specified range (T_1, T_2) or when the period of a vibration on at least two driven wheels reaches a specified limit value.

3. Method according to Claim 2, **characterized in that** a wheel acceleration limit value (B_{lim}) is specified within a range of 1g to 2g, preferably about 1.5g.

4. Method according to Claim 2 or 3, **characterized in that** a period range (T_1, T_2) of 30 msec. (T_2) to 150 msec. (T_1) or a limit value for the period of about 50 msec. is specified.

5. Method according to one of the Claims 1 to 4, **characterized in that** a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the driven wheels exhibit a specified traction slip.

6. Method according to Claim 5, **characterized in that** a traction slip is specified within a range of 0 km/h (S_2) to 50 km/h (S_1).

7. Method according to one of the Claims 1 to 6, **characterized in that** a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the calculated or estimated vehicle reference speed (V_{ref}) falls below a specified vehicle speed limit value (V_{lim}).

8. Method according to Claim 7, characterized in that a vehicle speed limit value (V_{lim}) is specified within a range of 60 km/h to 100 km/h, preferably about 80 km/h.

9. Method according to one of the Claims 1 to 8, **characterized in that** a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the conditions for a gravel road according to Claims 1 to 8 were identified in a vehicle with all-wheel drive on both wheels of one side of the vehicle and/or a vehicle axle.

10. Method according to one of the Claims 1 to 8, **characterized in that** a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is only activated when the conditions for a gravel road according to Claims 1 to 8 were identified in a vehicle with one driven axle on both wheels on the driven axle.

11. Method for controlling a vehicle, such as an anti-lock system (ABS), traction slip control (TCS) or driving-dynamics control system (EDS), in which the rotation behavior of the individual wheels is measured and evaluated to determine the vehicle reference speed, wheel slip, wheel acceleration and other control values used for evaluating and/or modulating the brake pressure in the wheel brakes of the wheels being controlled and/or an intervention in the engine management, **characterized in that** an engine control threshold and/or brake control threshold is increased to a specified value after a gravel road has been identified, especially by means of a method according to one of the Claims 1 to 10.

12. Method according to Claim 11, **characterized in that** an engine control threshold is predefined in a range of 2 km/h to 10 km/h, preferably about 3 km/h, and/or a brake control threshold is predefined in a range of 0 km/h to 10 km/h, preferably about 3 km/h.

13. Method according to Claim 11 or 12, **characterized in that** the brake control threshold is increased only when strongly overspeeding wheels are detected.

14. Circuit arrangement for controlling a vehicle, such as an anti-lock system (ABS, traction slip control (TCS) or driving-dynamics control system (ESP), **characterized in that** such circuit exhibits an identification circuit (20) to identify a gravel road or a similar road with higher slip requirement, wherein a detection circuit (21) for detecting the vibration behavior of the individual wheels is associated with the identification circuit (20), and the output (22) of the detection circuit (21) is connected to an input (23) of an evaluation circuit (24) for evaluating the detected vibration behavior, and the identification circuit (20) exhibits an integrator (25) and a signal generator (26) for generating a signal when a certain vibration behavior typical for gravel roads is detected on the wheels over a period of time predefined by the integrator (25) with the help of the evaluation of the evaluation circuit (23).

15. Circuit arrangement according to Claim 14, **characterized in that** a calculating circuit (27) is associated with the identification circuit (20), which calculates the vehicle reference speed on the basis of measured values and whose output (28) is connected to an input (29) of a first comparator (30) which is used for comparing the calculated vehicle reference speed with a specified limit value and is connected via an output (31) to an input (32) of the evaluation circuit (23) which compares the detected vibration behavior of the individual wheels, in particular the period of vibration, with specified limit values; that the identification circuit (20) exhibits a second comparator (33) for comparing the wheel acceleration with a wheel acceleration limit value, a third comparator (34) for comparing the vibration behavior of the individual wheels to one another, and a fourth comparator (35) for comparing the traction slip of the wheels with a specified limit value; and that the signal generator (26) is

connected via an output (36) to an input (37) of a device (38) used for intervening in the brake control and/or engine control when an appropriate signal for an identified driving situation on a gravel road is emitted.

Abstract

Method and Circuit Arrangement for Controlling a Vehicle

The invention relates to a method for controlling a vehicle, in which the rotation behavior of the individual wheels is measured and evaluated to determine the control values that are to be used for proportioning and/or modulating the brake pressure in the wheel brakes of the wheels being controlled and/or for an intervention in the engine management, wherein the vibration behavior of the individual wheels, particularly the wheels on the driven axle, is detected and evaluated in order to identify a gravel road or a similar road with a higher slip requirement. The driving situation of a gravel road is then considered to have been identified and/or a corresponding control function of the vehicle control system is activated only when the wheel acceleration on at least two wheels exceeds a predefined wheel acceleration limit value and these two wheels exhibit a certain vibration behavior.

(Figure 1)

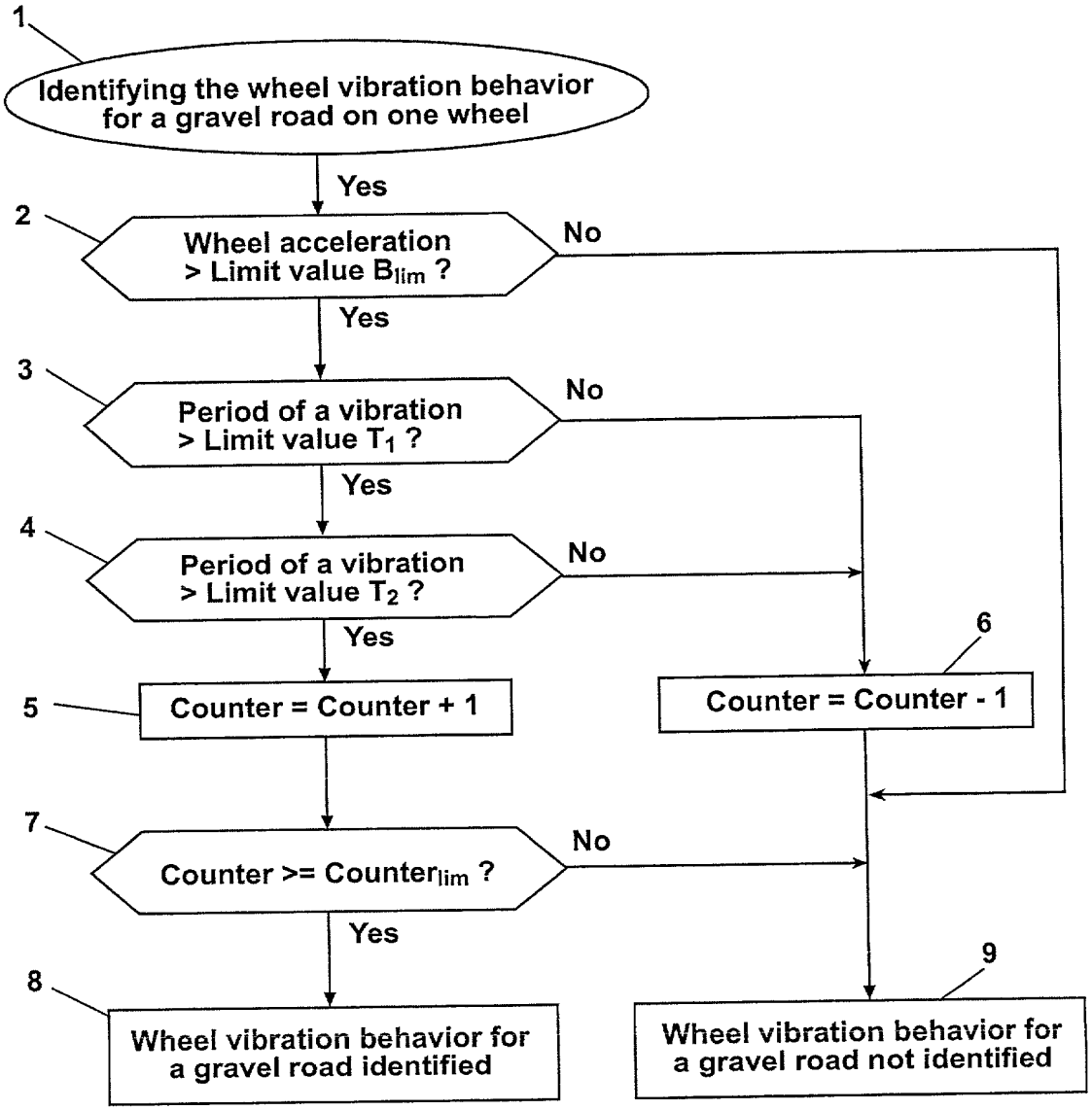

Fig. 1

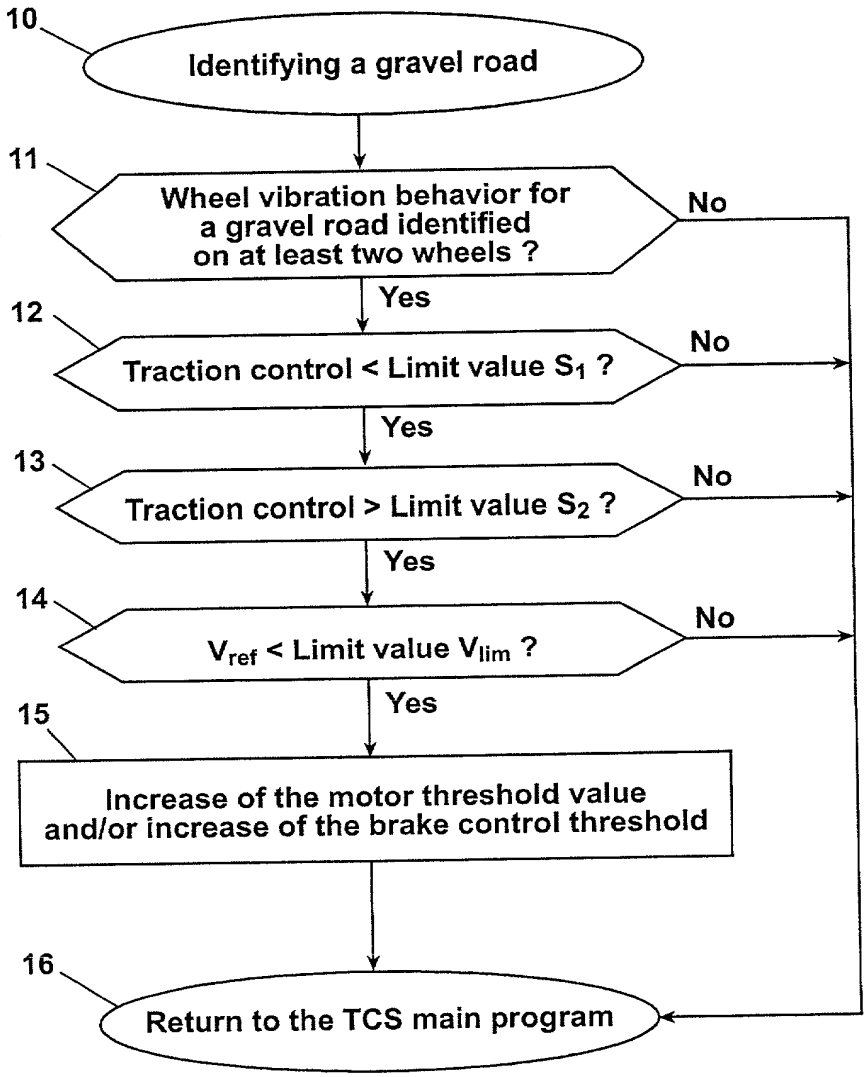
10
Identifying a gravel road
11
Wheel vibration behavior for a gravel road identified on at least two wheels ?
No
Yes
12
Traction control < Limit value S_1 ?
No
Yes
13
Traction control > Limit value S_2 ?
No
Yes
14
V_{ref} < Limit value V_{lim} ?
No
Yes
15
Increase of the motor threshold value and/or increase of the brake control threshold
16
Return to the TCS main program

Fig. 2

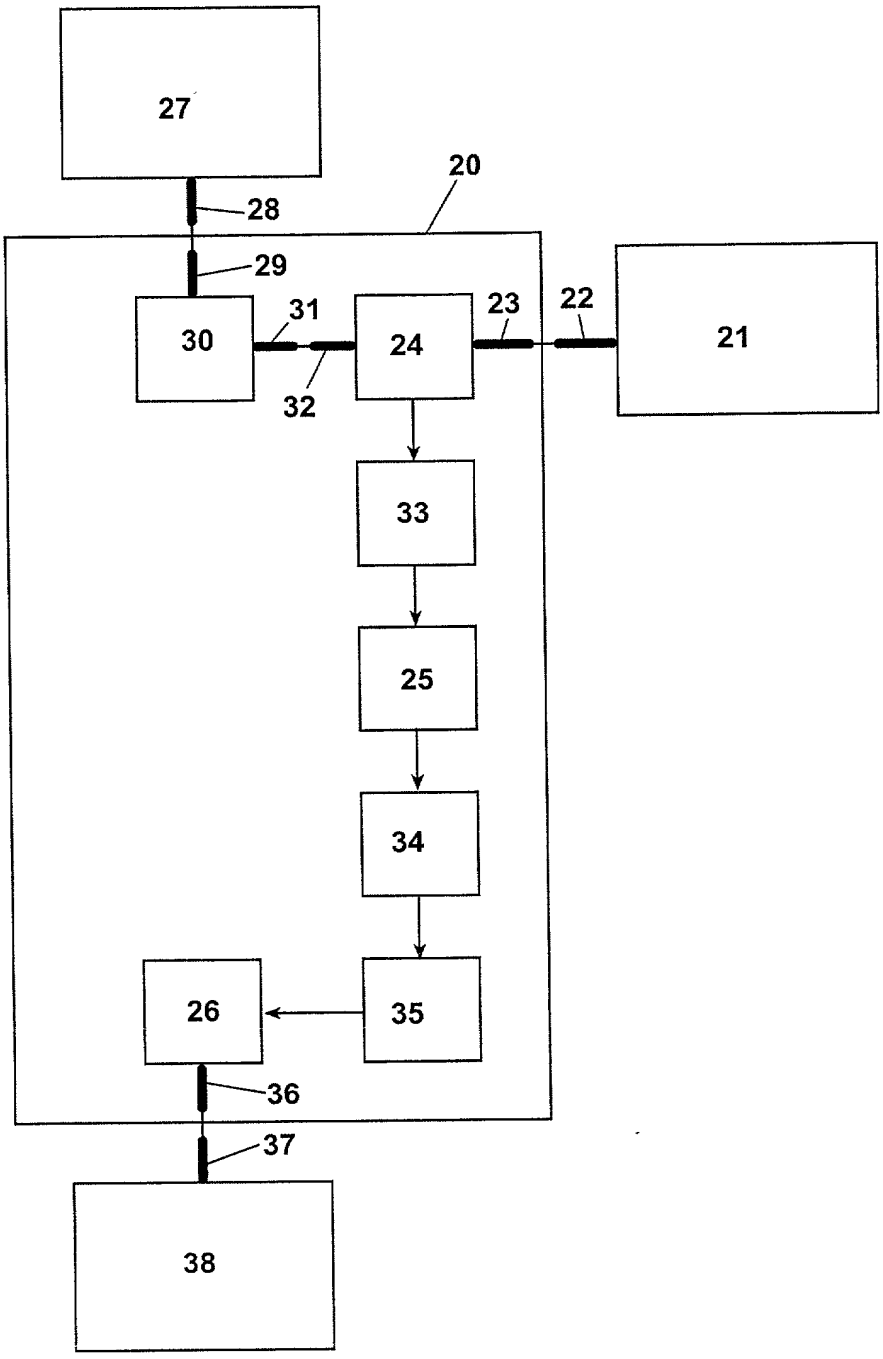

Fig. 3

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I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHOD AND CIRCUIT ARRANGEMENT FOR CONTROLLING A VEHICLE

the specification of which is attached hereto unless the following box is checked:

☒ was filed on **20/JULY/2000**
as United States Application Number or PCT International Application Number **PCT/EP00/06955**

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above and as amended in a preliminary amendment.

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Prior Foreign Applications (Frühere ausländische Anmeldungen)			Priority Not Claimed Priorität nicht beansprucht
19933387.4	**Germany**	**21/July/1999**	☐
10020215. 2	**Germany**	**25/April/2000**	☐
Number	Country	Day/Month/Year Filed	

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Application No. , filed on

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Application No. , filed on

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Status: patented/pending/abandoned)

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Joseph V. Coppola 33,373
Customer No. 010291

Korrespondenzadresse:
Joseph V. Coppola, Sr.
Rader, Fishman & Grauer PLLC
Suite 140
39533 Woodward Avenue
Bloomfield Hills MI 48304
Telefon: (248) 594-0650

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

Joseph V. Coppola 33,373
Customer No. 010291

Correspondence Address:
Joseph V. Coppola, Sr.
Rader, Fishman & Grauer PLLC
Suite 140
39533 Woodward Avenue
Bloomfield Hills MI 48304
Phone No.: (248) 594-0650

FIRST NAMED INVENTOR

1 - 00 **NORBERT EHMER**

01/10/02
Signature Date

P.O. ADDRESS and RESIDENCE

Rhönweg 10
D-65760 Eschborn, Germany DEX

Citizen of Germany

SECOND NAMED INVENTOR

2 - 00 **RAINER KLUSEMANN**

01/10/02
Signature Date

P.O. ADDRESS and RESIDENCE

Sonnenweg 109
D-60529 Frankfurt/ M., Germany DEX

Citizen of Germany

THIRD NAMED INVENTOR

3 - 00 **LOTHAR KIENLE**

01/10/02
Signature Date

P.O. ADDRESS and RESIDENCE

Mozartstraße 11
D-68623 Lampertheim, Germany

Citizen of Germany

FOURTH NAMED INVENTOR

4 - 00 **Dr. BERND-UWE HARTMANN**

01/10/02
Signature Date

P.O. ADDRESS and RESIDENCE

Lerchenweg 1
63584 Gründau, Germany

Citizen of **Germany**

☐ If box is checked, subsequent inventors are listed on a separate sheet

(S)
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Joseph V. Coppola 33,373
Customer No. 010291

Korrespondenzadresse:
Joseph V. Coppola, Sr.
Rader, Fishman & Grauer PLLC
Suite 140
39533 Woodward Avenue
Bloomfield Hills MI 48304
Telefon: (248) 594-0650

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

Joseph V. Coppola 33,373
Customer No. 010291

Correspondence Address:
Joseph V. Coppola, Sr.
Rader, Fishman & Grauer PLLC
Suite 140
39533 Woodward Avenue
Bloomfield Hills MI 48304
Phone No.: (248) 594-0650

FIFTH NAMED INVENTOR

5 - ∞ **ULRICH STÖCKMANN**

Ulrich Stöckmann 01/10/02
Signature Date

P.O. ADDRESS and RESIDENCE

Dernburgweg 5
64289 Darmstadt, Germany

Citizen of Germany

SIXTHD NAMED INVENTOR

Signature Date

P.O. ADDRESS and RESIDENCE

Citizen of

SEVENTH NAMED INVENTOR

Signature Date

P.O. ADDRESS and RESIDENCE

Citizen of

EIGTH NAMED INVENTOR

Signature Date

P.O. ADDRESS and RESIDENCE

Citizen of